CLAIMS

1.   A method of processing bit mapped image data representing the intensity of each of a plurality of pixels forming an image of an area of an individual's retina including the optic disk to generate a signal pattern to verify the identity of the individual,

5   comprising:

finding a boundary of the optic disk in the image represented by said pixel data;

generating a signal pattern representing the intensity of pixels having a predetermined relationship with respect to the boundary of the

10   optic disk; and

comparing the generated signal pattern to a stored signal pattern to verify the identity of the individual.

2.   A method of processing data representing an image of a retina including the optic disk as recited in claim 1 wherein the step of finding the optic disk boundary includes fitting an ellipse onto the optic disk image represented by said pixel data.

3.   A method of processing data representing an image of a retina including the optic disk as recited in claim 2 wherein the step of fitting the ellipse onto the optic disk includes calculating a first function representing the average intensity of the pixels within an ellipse.

4.   A method of processing data representing an image of a retina including the optic disk as recited in claim 2 wherein the step of fitting the ellipse onto the optic disk includes calculating a second function representing an average edge strength for pixels in an edge area

5   of the ellipse.

5.   A method of processing data representing an image of a retina including the optic disk as recited in claim 1 wherein said signal pattern generating step includes:

calculating the average intensity of pixels within a predetermined distance of said boundary for each of a plurality of positions along the boundary; and

forming the signal pattern from the calculated average intensities.

6.   A method of processing data representing an image of a retina including the optic disk as recited in claim 1 wherein said signal pattern generating step includes:

defining at least one path within the boundary of the optic disk;

calculating the average intensity of pixels about the path for each of a plurality of positions along the path; and

forming at least a portion of the signal pattern from the calculated average intensities.

7.   A method of processing data representing an image of a retina including the optic disk as recited in claim 1 wherein said signal pattern generating step includes:

defining at least one path outside of the boundary, the path having a predetermined relation to the boundary;

calculating the average intensity of pixels about the path for each of a plurality of positions along the path; and

forming at least a portion of the signal pattern from the calculated average intensities.

8.   A method of processing data representing an image of a retina including the optic disk as recited in claim 7 wherein said path is an elliptical path concentric with said boundary.

9.   A method of processing data representing an image of a retina including the optic disk as recited in claim 7 wherein said path is adjacent to the boundary.

10.   A method of processing data representing an image of a retina including the optic disk as recited in claim 1 wherein said signal generating step includes:

defining a plurality of sectors within the boundary;

calculating the average intensity of the pixels within each of the sectors; and

forming   the   signal   pattern   from   the   calculated   average intensities.

11.   A method of processing data representing an image of a retina including the optic disk as recited in claim 1 further including the step of estimating a center of the optic disk from a location of a group of the highest intensity pixels in the image.

12.   A method of processing data representing an image of a retina including the optic disk as recited in claim 1 wherein the step of finding the boundary includes determining the location of the pixels in the bit mapped image representing an elliptical boundary of the optic disk.

13.   A   method   of   processing   bit   mapped   image   data representing the intensity of each of a plurality of pixels forming an

image of an area of an individual's retina including the optic disk to generate a signal pattern to verify the identity of the individual,

5 comprising:

determining a location of the optic disk in the image from said pixel data;

fitting a contour approximating a shape of at least a portion of the optic disk onto the image of the optic disk represented by said pixel

10 data; and

generating a signal pattern representing an average intensity of the pixels at a plurality of positions determined with respect to said contour.

14. A method of processing data representing an image of a retina including the optic disk as recited in claim 13 wherein the contour is a portion of an ellipse.

15. A method of processing data representing an image of a retina including the optic disk as recited in claim 13 wherein the location of the optic disk is determined by estimating a center of the optic disk from a group of the highest intensity pixels in the image.

16. A method of processing data representing an image of a retina including the optic disk as recited in claim 13 further including the step of comparing the generated signal pattern to a stored signal pattern to verify the identity of the individual.

17. A method of processing bit mapped image data representing the intensity of each of a plurality of pixels forming an image of an area of an individual's retina including the optic disk to

generate a signal pattern to verify the identity of the individual,

5   comprising:

fitting a circle onto the image of the optic disk represented by said pixel data;

distorting the circle into an ellipse to fit an ellipse onto the image of the optic disk represented by the pixel data; and

10   generating a signal pattern representing an average intensity of the pixels at a plurality of positions determined with respect to the ellipse.

18.   A method of processing data representing an image of a retina including the optic disk as recited in claim 16 including the step of   17 determining a location of a center of the ellipse relative to said image data, a major axis length, a minor axis length and an angle defining the

5   position of the major axis relative to a reference so as to define the location of the pixel data representing a boundary of the optic disk.

19.   A method of processing data representing an image of a retina including the optic disk as recited in claim 18 wherein said signal pattern generating step includes:

calculating the average intensity of pixels within a predetermined

5   distance of said boundary for each of a plurality of positions along the boundary; and

forming the signal pattern from the calculated average intensities.

20.   A method of processing data representing an image of a retina including the optic disk as recited in claim 18 wherein said signal pattern generating step includes:

defining at least one path within the boundary of the optic disk;

5   calculating the average intensity of pixels about the path for each of a plurality of positions along the path; and

forming at least a portion of the signal pattern from each of the calculated average intensities.

21.   A method of processing data representing an image of a retina including the optic disk as recited in claim 18 wherein said signal pattern generating step includes:

defining at least one path outside of the boundary, the path

5   having a predetermined relation to the boundary;

calculating the average intensity of pixels about the path for each of a plurality of positions along the path; and

forming at least a portion of the signal pattern from the calculated average intensities.

22.   A method of processing data representing an image of a retina including the optic disk as recited in claim 21 wherein said path is an elliptical path concentric with said boundary.

23.   A method of processing data representing an image of a retina including the optic disk as recited in claim 21 wherein said path is adjacent to the boundary.

24.   A method of processing data representing an image of a retina including the optic disk as recited in claim 18 wherein said signal generating step includes:

defining a plurality of sectors within the boundary;

5   calculating the average intensity of the pixels within each of the sectors; and

forming the signal pattern from the calculated average intensities.

25.   A method of processing data representing an image of a retina including the optic disk as recited in claim 17 wherein the step of fitting a circle onto the image of the optic disk includes calculating a first function representing the average intensity of the pixels within a circle.

26.   A method of processing data representing an image of a retina including the optic disk as recited in claim 17 wherein the step of fitting the circle onto the optic disk image includes calculating a second function representing an average edge strength for pixels in an edge area of the circle.

27.   A method of processing data representing an image of a retina including the optic disk as recited in claim 17 wherein the step of fitting the ellipse onto the optic disk includes calculating an average edge strength for pixels in an edge area of the ellipse.

28.   A method of processing data representing an image of a retina including the optic disk as recited in claim 17 further including the step of estimating a center of the optic disk from a location of a group of the highest intensity pixels in the image.

29.   A method of processing data representing an image of a retina including the optic disk as recited in claim 17 further including the step of comparing the generated signal pattern to a stored signal pattern to verify the identity of the individual.

30.   A method of processing data representing an image of a retina including the optic disk as recited in claim 17 wherein the step of fitting a circle onto the image of the optic disk includes:

determining an approximate center of an optic disk based on a location of a group of pixels having the highest intensity pixel data;

setting a circle radius to a value greater than or less than the radius of an optic disk;

determining the average intensity of pixels inside the circle and the average edge strength of the pixels about a perimeter of the circle; and

changing the circle radius and/or center to produce the greatest increase in the average intensity of the pixels inside the circle and a change in an average edge strength of the pixels about a perimeter of the circle that is greater than a predetermined value.

31.   A method of processing bit mapped image data representing the intensity of each of a plurality of pixels forming an image of an area of an individual's retina including the optic disk to generate a signal pattern to verify the identity of the individual, comprising:

fitting a circle onto the image of the optic disk represented by said pixel data by changing a center and radius of the circle based on an average intensity of the pixels within the circle and/or an average edge strength of the pixels about a circumference of the circle;

distorting the circle into an ellipse to fit an ellipse onto the image of the optic disk represented by the pixel data; and

generating a signal pattern representing an average intensity of the pixels at a plurality of positions determined with respect to the ellipse.

32.   A method of processing data representing an image of a retina including the optic disk as recited in claim 31 including the step of determining a location of a center of the ellipse relative to said image data, a major axis length, a minor axis length and an angle defining the

5   position of the major axis relative to a reference so as to define the location of the pixel data representing a boundary of the optic disk.

33.   A method of processing data representing an image of a retina including the optic disk as recited in claim 31 wherein said signal pattern generating step includes:

calculating the average intensity of pixels within a predetermined

5   distance of said boundary for each of a plurality of positions along the boundary; and

forming the signal pattern from the calculated average intensities.

34.   A method of processing data representing an image of a retina including the optic disk as recited in claim 31 wherein said signal pattern generating step includes:

defining at least one path within the boundary of the optic disk;

5   calculating the average intensity of pixels about the path for each of a plurality of positions along the path; and

forming at least a portion of the signal pattern from the calculated average intensities.

35.   A method of processing data representing an image of a retina including the optic disk as recited in claim 31 wherein said signal pattern generating step includes:

defining at least one path outside of the boundary, the path

5   having a predetermined relation to the boundary;

calculating the average intensity of pixels about the path for each of a plurality of positions along the path; and

forming at least a portion of the signal pattern from the calculated average intensities.

36.   A method of processing data representing an image of a retina including the optic disk as recited in claim 35 wherein said path is an elliptical path concentric with said boundary.

37.   A method of processing data representing an image of a retina including the optic disk as recited in claim 35 wherein said path is adjacent to the boundary.

38.   A method of processing data representing an image of a retina including the optic disk as recited in claim 31 wherein said signal generating step includes:

defining a plurality of sectors within the boundary;

5   calculating the average intensity of the pixels within each of the sectors; and

forming the signal pattern from the calculated average intensities.

39.   A method of processing data representing an image of a retina including the optic disk as recited in claim 31 wherein the step of fitting the ellipse onto the image of the optic disk includes

determining the average edge strength of the pixels about a

5   perimeter of the ellipse; and

changing one or more parameters defining the ellipse until the average edge strength no longer increases.

40. A method of processing data representing an image of a retina including the optic disk as recited in claim 31 wherein the step of fitting a circle onto the image of the optic disk includes:

determining an approximate center of an optic disk based on a group of pixels having the highest intensity pixel data;

setting a circle radius to a value greater than or less than the radius of an optic disk;

determining the average intensity of pixels inside the circle and the average edge strength of the pixels about a perimeter of the circle; and

changing the circle radius and/or center to produce the greatest increase in the average intensity of the pixels inside the circle and a change in the average edge strength of the pixels about a perimeter of the circle that is greater than a predetermined value.

41. A method of processing data representing an image of a retina including the optic disk as recited in claim 31 further including the step of comparing the generated signal pattern to a stored signal pattern to verify the identity of the individual.

42. A method of processing bit mapped image data representing the intensity of each of a plurality of pixels forming an image on an area of an individual's retina including the optic disk to generate a signal pattern to verify the identity of the individual comprising:

locating an approximate center of the optic disk in the image represented by the pixel data based on the intensity of a group of pixels;

fitting a circle onto the image of the optic disk represented by the pixel data starting with a circle having a center set equal to the located approximate center and a radius that is greater than or less than a radius

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of the optic disk and changing the center and/or radius to fit the circle on the optic disk;

distorting the circle into a ellipse to approximate a shape of the optic disk; and

15   generating a signal pattern representing an average intensity of the pixels at a plurality of positions determined with respect to the ellipse.

43.   A method of processing data representing an image of a retina including the optic disk as recited in claim 42 further including the step of comparing the generated signal pattern to a stored signal pattern to verify the identity of the individual.